POWERED ANTITHROMBOTIC FOOT MOBILITY DEVICE

The application claims priority from U.S. Provisional Ser. No. 60/313,541, filed Aug. 20, 2001, which is hereby incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates broadly to exercise devices. More particularly, this invention relates to exercise devices which promote circulation in the lower extremities by movement of the foot about a pivot.

2. State of the Art

Deep vein thrombosis (DVT) refers to the formation of a thrombus (blood clot) within a deep vein, commonly in the thigh or calf. The blood clot can travel to the lungs, resulting in pulmonary embolism, a potentially life-threatening condition.

DVT occurs when the flow of blood is restricted in a vein, and can be caused by poor circulation because of problems such as heart disease, a recent heart attack or stroke, varicose veins, or from inactivity or prolonged bed rest. Recently, a lot of attention has been focused on DVT developed during long airplane

flights and deaths resulting therefrom. In fact, DVT has been dubbed 'economy class syndrome' because the less expensive seats in a plane have less leg room, limited leg movement. However, DVT is not confined to economy class or to long haul flights.

In view of current and impending lawsuits by passengers with respect to DVT, airlines have become proactive in trying to prevent the condition and are now directing passengers to get up and walk around the airplane cabin at least once an hour to increase blood circulation. However, flights are subject to meal service and turbulence which limit the amount of time available for passengers to exercise their legs. Moreover, flights are crowded and it is not feasible for all the passengers to walk through the narrow aisles in the cabin.

As a response, a number of devices are being promoted to increase blood circulation while a passenger remains seated. For example, the LYMPHA-PRESS® SKY WALKER™ device by Mego Afek of Kibbutz Afek, Israel, is a portable, foldable exercise device operated from a seated position. The device includes two foot pedals which are not subject to any resistance other than minimal friction forces. When the user wants to increase circulation, the pedals can be easily moved by the feet of a user in a pedaling motion. The simple pedal movement of the user's feet effects contraction of the calf muscles which assists in moving venous

blood back to the heart, augmenting arterial blood inflow and preventing thrombosis.

However, this and similar devices have a common drawback when used for the purpose of preventing DVT on long airplane flights; they require too much effort. Even the SKY WALKER™ device, which offers substantially no resistance, requires the user to concentrate on the movement of the feet. That is, if the user concentrates on the in-flight movie or a magazine, it is easy to forget to continue to pedal and DVT can result.

U.S. Patent No. 6,217,488 to Bernardson discloses another lower leg exerciser which includes a base, foot pedals which rock along a pivot relative to the base, and a motor adapted to rock the pedals back and forth. When feet are placed on the pedals, the feet are rocked automatically and blood circulation in the legs is increased. However, the Bernardson device has several drawbacks. First, the rocking movement of the feet causes the knees to move up and down. This motion is not suited to airplane travel, as the room in front of a seat is limited, and once the user's feet are raised and placed on the device, the rocking motion may cause the user's knees to contact the back of the chair in front, may cause interference with a tray table, or may be annoying if, e.g., trying read a book held on the lap. A second drawback is that the Bernardson device cannot be reconfigured to a

smaller size for increased portability. A third drawback is that should a power supply be unavailable for powering the device, i.e., no suitable power outlet or depleted batteries, the device does not provide anti-DVT exercising of the legs.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a foot mobility device which moves the feet in a manner which limits knee movement.

It is another object of the invention to provide a foot mobility device which requires no effort on the part of the user.

It is an additional object of the invention to provide a foot mobility device which is portable.

It is also an object of the invention to provide a foot mobility device which has a low profile.

It is still another object of the invention to provide a foot mobility device which has a collapsed configuration.

It is a further object of the invention to provide a foot mobility device which can be used as either a passive (powered) or active (non-powered) exercise device.

In accord with these objects, which will be discussed in detail below, a foot mobility device is provided and includes a body, two pedals rotatable about a common axis preferably in opposition to each other and relative to the body, and a motor drive assembly coupled to the pedals. The feet of a user are placed on the pedals, and the motor drive assembly is powered to cause movement of the pedals even while the user is completely passive; i.e., without any active participation by the user. Moreover, the sensation received by the use, rather than being one of typical "exercise", is massage-like and therapeutic, all while providing the same benefit of increased blood circulation due to contraction and relaxation of the calf muscle. Moreover, the foot mobility device may be moved between an open configuration adapted for use of the device and a collapsed configuration having a low profile and adapted for storage and portability.

According to one embodiment of the invention, the foot mobility device includes a generally vertically oriented body, two foot pedals hingedly coupled on either side of the body to rotate substantially ninety degrees relative to the body between a closed position in which each foot pedal is substantially parallel to the

body and an open position in which each foot pedal is substantially perpendicular to the body. In the open position, the pedals are adapted to cause feet placed thereon to rotate about the ankle joint.

According to other embodiments of the invention, the foot mobility device includes a preferably flat base, two pedals rotatable about a heel pivot, and a motor mechanism which rotates the pedals. The motor mechanism is movable from a first position in which it lies against the base to an upright second position in which it is adapted to move the pedals. The pedals can be configured to lie flat against the base for storage and portability. In addition, the pedals can preferably be disengaged from the motor drive so that the device can be used as an active exercise device and also to facilitate moving the pedals for folding the device in a highly portable configuration.

It will be appreciated that with the foot mobility device of the invention, a highly compact and therefore portable powered foot mobility device is provided.

Additional objects and advantages of the invention will become apparent to those skilled in the art upon reference to the detailed description taken in conjunction with the provided figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a first embodiment of a portable foot mobility device with the pedals in an open configuration;

Fig. 2 is a perspective view similar to Fig. 1, but in which a left housing element has been removed such that the interior of the housing can be seen;

Fig. 3 is a perspective view similar to Fig. 2, with the additional removal of the left pedal, left rocker, and left gearbox housing, and with front and rear legs in a closed position;

Fig. 4 is a perspective view of the first embodiment of the portable foot mobility device with the legs in an open position;

Fig. 5 is a perspective view of the foot mobility device in a closed configuration;

Figs. 6(a) - 6(f) are perspective views similar to Fig. 4 illustrating the range of motion of the right pedal;

Fig. 7 is a perspective view of a second embodiment of the foot mobility device of the invention in an open configuration;

Fig. 8 is a side elevation view the second embodiment of the foot mobility device of the invention in an open configuration;

Fig. 9 is a top view of the second embodiment of the foot mobility device of the invention in a closed configuration;

Fig. 10 is a side elevation view of the second embodiment of the foot mobility device of the invention in an open configuration;

Figs. 11 - 13 are schematic views of the gear and switch assembly which operates reciprocable movement of the foot pedals in the second embodiment of the foot mobility device of the invention;

Figs. 14 and 15 are schematic views of the engagement and disengagement, respectively, of the gearbox from the drive gear, and also of the power switch operation in the second embodiment of the foot mobility device of the invention;

Figs. 16(a) - 16(d) are schematic views of a third embodiment of a foot mobility device according to the invention, shown in

several positions as being moved from an open configuration to a closed configuration;

Figs. 17 and 18 are schematic view of a first mechanism for automatically disengaging the drive train from the pedals in the second and third embodiments of the invention;

Fig. 19 is a schematic view of a second mechanism for automatically disengaging the drive train from the pedals in the second and third embodiments of the invention;

Fig. 20 is a perspective view of a fourth embodiment of the invention, in a collapsed configuration;

Fig. 21 is a perspective view of the fourth embodiment of the invention, in an open configuration;

Fig. 22 is a perspective view of the fourth embodiment of the invention, illustrating the maximum rise of one pedal relative to the other;

Fig. 23 is a perspective view of the fourth embodiment of the invention with the left pedal removed to show the four-bar linkage support of the motor housing in the open configuration;

Fig. 24 is a perspective view of the fourth embodiment of the invention, in an open configuration also showing the pedal at full travel (maximum rise);

Fig. 25 is a perspective view of one side of the gear box of fourth embodiment;

Fig. 26 is a perspective view of the other side of the gear box of fourth embodiment;

Fig. 27 is a perspective view of the gear train, with the device in the 'OFF' position such that the idler gear of the gear train is not engaged;

Fig. 28 is a perspective view of the gear train, with the device in the 'ON' position such that the idler gear of the gear train motor is engaged;

Fig. 29 is a perspective view of the gear train, four bar linkage, and switching mechanism; and

Fig. 30 is a schematic view of a passenger compartment of a vehicle having foot mobility device according to the invention integrated into or coupled to the floor thereof.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to Fig. 1, a first embodiment of a foot mobility device 10 is shown. The device generally includes an upstanding housing 12 (preferably defined by left and right housing members 14, 16), and left and right pedals 18, 20 rotatable relative to the housing. The left and right pedals 18, 20 function as foot rests when in the open position shown in Fig. 1 (oriented perpendicular to the housing), but are respectively rotatable by ninety degrees about hinges 22 into an upright position substantially parallel to the housing (Fig. 6), as discussed below. Front and rear legs 24, 26 respectively, described in more detail below, support the device on a surface away from the floor to allow clearance for pedal movement and provide stability for the housing 12.

Turning now to Figs. 2 and 3, the pedals 18, 20 are coupled to a gearbox 30 having a housing 31 defined by left and right housing elements 32, 33. More particularly, the pedal hinges 22 couple the pedals 18, 20 to left and right rockers 34, 36 which are, in turn, coupled to the gearbox 30 with left and right rocker links 38, 40 using left and right rocker bushings 42, 44. Three preferably identical roller bearings 46 are mounted to the housing on roller bearing mounts 48. The weight of the user's feet and legs tends to force the rockers 34, 36 toward each other, and the

roller bearings 44 maintain separation between the two rockers 34, 36. The diameter of each of the roller bearings 46 is equal to the desired distance between the left and right rockers.

Referring particularly to Fig. 3, the gearbox housing 31 encases a motor 50, powered by batteries 52 located inside the housing 12. The motor 50 has an output shaft (not shown) which rotates in a preferably counter-clockwise direction, as viewed from the shaft end of the motor. The output shaft is provided with a motor pulley 54 which drives a worm pulley 56 by means of a belt 58 for purposes of isolating motor vibration and reducing noise. The worm pulley 56 is preferably a one-piece component with a pulley 60 at one end and a right-handed worm screw 62 coaxially located at the other end. The worm pulley 56 is rotatably mounted on a steel shaft (not shown) that is rigidly provided in gearbox housing 31. The worm screw 62 engages a shaft-mounted compound worm gear 64. The compound worm gear 64 has a spur gear 66 coaxially affixed to the worm gear, and the spur gear 66 engages a compound gear 68. The compound gear 68 engages an idle gear 70 which, in turn, engages a cam gear 72. Unlike the rest of the gears, the cam gear 72 preferably does not pivot on a shaft, but rather includes an annular projection 74 on each of its sides which is inserted into corresponding holes 76 in the left cam gear bearing 78 and right cam gear bearing (not shown).

The cam gear 72 also has an additional annular projection 80 on each of its sides. The projections 80 are smaller in diameter than projection 74 and are parallel to, but not coaxial with, the axis of rotation of cam gear 72. These projections, one on the left side and one on the right, are 180° out of phase with each other. The projections 80 provide a pivot joint for the attachment of the left and right rocker links 38, 40. The rotation of cam gear 72 causes the gearbox ends of the rocker links to travel in circular paths. The other end of each of the rocker links is attached to a respective rocker 34, 36. For example, right rocker link 40 is rotatably mounted to the right rocker 36 by means of rocker link bearing 44. The rocker link bearing 44 is screwed to the right rocker 36 and has a flange 82 such that the right rocker link 40 is trapped between the flange 82 and the face 84 of the rocker 36.

The right rocker 36 is pivotably mounted on a rocker bearing 86 which is located and trapped between bosses 88 that project inward from both the left and right housing members 14, 16.

Referring to Figs. 3 and 4, the front leg 24 is connected to the gearbox 30 with a gearbox link 89. When the front leg 24 is in the closed (folded) position (Fig. 3), the gearbox 30 is spaced apart from the front wall 90 of the housing 12. When the front leg 24 is pulled into the open position (Fig. 4), the gearbox link

90 is pulled, which in turn moves the gearbox 30 away from the rockers 34, 36 and toward the front wall 90 of the housing 12 (compare Figs. 3 and 4). The movement of the gearbox 30 away from the rockers 34, 36 pulls the rocker links 38, 40, which pulls the rockers 34, 36. In the folded position of Fig. 3, the position of the gearbox 30 locates the rocker links 38, 40 and rockers 34, 36 at the midpoint of the pedal movement cycle, where each pedal 18, 20 is halfway between up and down and parallel to each other such that the pedals, when folded about hinges 22, are aligned with the housing 12, as shown in Fig. 5. When the front leg 24 is unfolded such that the gearbox 30 is moved toward the front wall 90 of the housing as shown in Fig. 4, the position of the gearbox 30, rocker links, and rockers orients the pedals at an angle relative to a surface on which the foot mobility device rests (i.e., in the middle position of the pedal movement cycle), and ready for use. It is noted that the cam gear 72 is not at all moved by the folding the front leg 24 between the open and closed positions.

Still referring to Figs. 3 and 4, the rear leg 26 telescopes into and out of a rear portion 92 of the housing 12. A resilient catch 94 automatically locks against the bottom 96 of the housing when the rear leg 26 is moved into an extended position, but may easily be released by finger pressure to collapse the rear leg back into the housing.

Referring now to Figs. 6(a)-(f) the full range of motion for the right pedal 20 is shown, with an understanding that left pedal 18 (Fig. 1) undergoes a similar though opposite motion. Fig. 6(a) depicts the lowest position for pedal 20, Fig. 6(c) depicts the middle, or folding, position for the pedal, Fig. 6(b) depicts a position between Figs. 6(a) and 6(c), Fig. 6(e) depicts the maximum height position for pedal 20, Fig. 6(d) depicts a position between Figs. 6(c) and 6(e), and Fig. 6(f) depicts the pedal 20 on its way back toward the lowest position. The axis of rotation of the pedals 18, 20 is substantially about the location of the ankles of the feet placed on the pedals. This is facilitated by placing the foot pedals below the axis of rotation.

Referring back to Fig. 5, it is appreciated that the folding of the pedals 18, 20 against the housing 12 provides a device 10 with a small profile which is highly suitable for storage and travel. In the folded position, the entirety of the device has a preferred length to thickness to height ratio of approximately 14 to approximately 3 to approximately 7. These relative dimensions provide a device suitable for carry-on luggage or even a briefcase.

Turning now to Figs. 7 and 8, a second embodiment of a portable foot mobility device 100 is shown. The foot mobility device 100 generally includes a base 112, left and right foot

pedals 118, 120 rotatable up and down relative to the base on a hinges 122 at heel portions of the pedals, and a motor housing 130 also movable relative to the base. The base 112 includes a battery compartment 132 which is electrically coupled to a motor 140, discussed below, in the motor housing 130. The motor housing 130 is coupled to a pair of movable trusses 134, 136 and the motor housing and trusses are movable between a closed configuration, in which both are substantially flush with the base (Figs. 9 and 10), and an open configuration in which the trusses and a lower portion of the motor housing 130 assume a stable triangular configuration (Figs. 7 and 8).

Turning now to Fig. 11, the motor housing 130 includes a drive assembly. The drive assembly includes a motor 140 and a gearbox 180 (Fig. 14) provided with gears. The motor 140 has an output shaft 142 provided with a spur gear 144. The spur gear 144 engages a first shaft-mounted compound gear 146 which engages a second shaft-mounted compound gear 148 to step down the rotational transmission of the motor 140. A spur gear portion 150 of the second compound gear 148 engages a spur gear portion 152 of a drive gear 154, which is located outside the gear box 180. The drive gear 154 also includes a pulley portion 156. Left and right pulleys 158, 160 are horizontally offset on either side of the pulley portion 156, and the pulley portion of the drive gear 154 moves a rope 162, or other flexible transmission line such as a

cable, across the pulleys 158, 160. The left and right pedals 118, 120 are each coupled to one end of the rope 162, as shown with respect to the left pedal in Fig. 8.

The motor drive 130 is also provided with a switch 170 having a contact arm 172 movable between two positions, with each position causing the motor 140 to rotate in an opposite rotational direction. The drive gear 154 includes a peg portion 174 on its face which extends sufficiently therefrom to interfere with the contact arm 172 at predetermined rotational positions so that the switch 170 may be activated.

The motor drive 130 operates the pedals 118, 120 in an up and down motion as follows. The contact arm 172 of the switch 170 is oriented in a position (e.g., to the left) causing counterclockwise rotation of the motor 140. Rotation of the spur gear 144 at the end of the motor shaft 142 results in rotation of gears 146, 148, 150 and consequently clockwise rotation of the drive gear 152, as indicated by the arrow in Fig. 11. The peg portion 174 on the drive gear 152 is thereby rotated to cause the peg portion 174 to contact the contact arm 172 (Fig. 12), and then to cause the contact arm to move into the second position which causes clockwise rotation of the motor and counterclockwise rotation of the drive gear 152 (Fig. 13). The drive gear 152 and peg 174 are then rotated counterclockwise until the peg 174 again

contact and moves the contact arm 172 to reverse the direction of the motor 140. Each time the drive gear 152 is rotated in an opposite direction, the rope is likewise pulled in an opposite direction, with the pedal at one end of the rope being raised, and the pedal at the other end of the rope being lowered.

Turning now to Fig. 14, according to a preferred aspect of the invention, the gears in the gearbox 180 may be disengaged from the drive gear 152 to facilitate closing (collapsing) the foot mobility device such that both pedals are substantially flush with the base 112. That is, when the gearbox is disengaged, the rope attached to the pedals may be moved without having to rotate all the gears in the gearbox against the resistance of the motor. According to a currently preferred disengagement (and engagement) mechanism, the gearbox 180 is provided with a cam 182 on its surface. The gearbox 180 is vertically movable within a slot defined by walls 184, 186. A horizontally movable lever 188 is provided with a cam slot 190 in which the cam 182 rides. The lever 188 preferably includes left and right button portions 192, 194. When the lever 188 is positioned to the left, as shown in Fig. 14, the cam 182 is forced into a portion of the slot 190 which causes the gearbox 180 to be in a vertical position which results in engagement of a gear in the gearbox with the drive gear 152. When the lever is moved to the right, as shown in Fig. 15, the cam 182 is forced vertically downward in the cam slot 190, and

the gear box 180 is disengaged from the drive gear 152. With the gearbox disengaged, the foot mobility device may be used as an active exercise device in which the user moves the pedals. This is particularly useful when the batteries are depleted, or when completely silent operation is desired.

Moreover, the same mechanism can be, though not necessarily is, used to complete and disrupt a power switch to activate and deactivate (i.e., turn ON and OFF) the device 100. Referring back to Fig. 14, contacts 196, 198 are required to be in electrical contact for the motor to receive power from the battery source. Contact 198 is resiliently biased away from contact 196. When the gearbox 180 is in the engaged position, gearbox forces contact 198 against contact 196, providing power from the battery source to the motor. However, when the gearbox is disengaged (Fig. 15), contact 198 moves away from contact 196 and power is removed.

According to another preferred aspect of the invention, the lever is preferably actuatable by foot, with the left and right button portions 192, 194 extending outside the housing 12, as shown in Figs. 7 through 9. As such, once the device is in the open position, it may be easily turned ON by using a user's foot to move the lever 188 into the ON position and likewise turned OFF in the same manner; i.e., by moving the lever in the opposite direction with one's foot. The foot activation is very

advantageous, especially when seated in a cramped airplane seat, where there is little room to bend to the floor and operate a device.

Turning now to Figs. 16(a) - 16(d), a third embodiment of the foot mobility device 200, substantially similar to the second embodiment, is shown. The foot mobility device 200 includes two pedals (only left pedal 218 shown in the figures) hinged to a base 212, a motor drive (not shown) in a central foldable motor drive housing 230, and a rope (or cable) 262 connecting the unhinged end of the pedals to the motor drive mechanism. When in the opened position of Fig. 16(a) and powered, the motor drive causes the pedals to move up and down about their hinges 222. When one pedal is down the other is up. The motor drive housing 230 is coupled to the base 212 by a four bar linkage (with the two left bars 234, 235 being shown, and similar right bars not shown) allowing the housing 230 to fold into intermediary positions shown in Figs. 16(b) and 16(c), and finally into the flat position of Fig. 16(d). Simultaneously with the folding, the tension on the rope 262 is released, such that the foot pedals 218, 220 are allowed to fold flat as well. To further allow for easy folding, the device 200 when folded automatically switches to OFF mode and disengages the motor from the gear train allowing the rope 262 to move freely so that if one pedal is all the way up the rope can easily adjust as the device is folded.

Referring to Fig. 17, one mechanism for automatically disengaging the drive train from the pedals is shown. A cog 260 is slidably coupled to the gearbox 280, and is biased by a first spring 262 toward the lever 288. A cable 261 is coupled at one of its ends to the cog 260, and at the other of its ends it is coupled to elsewhere on the device, as discussed below. The lever 288 includes a catch 264, and the cog 260 includes a beveled end 266 engageable within the catch 264 when the lever 288 is positioned such that the device 200 is in an ON position. A second spring 268 is coupled to the lever 288 and tensioned to pull the lever 288 with sufficient force move the cam 282 relative to the cam slot 290 such that the gearbox 280 is moved into a disengaged position. When the drive mechanism housing 230 is upright, the cable 261 is slack allowing the cog 260 to move under the tension of the first spring 262 so that the beveled end 266 of the cog 260 enters the catch 264 and holds the lever 288 in the engaged position, locking the lever in place against the tension of the second spring 268. Referring to Fig. 18, as soon as the housing (130 in the second embodiment, and 230 in the third embodiment) starts to move from the vertical position, either in its four bar linkage configuration (Figs. 16(a)-16(d)) or in its sliding configuration (Figs. 7 and 8), the cable 261 is caused to go taught, pulling the cog 260 from the catch 264, and allowing the lever 288 to spring, under the force of the second spring 268, into the OFF position, removing power and disengaging the motor

drive. For example, in the four bar linkage configuration of Figs. 16(a)-(d), either the pivoting action of the lower or upper bars 234, 235 can cause the cable 261 to go taught. In the sliding version of Figs. 7 and 8, either the pivoting of bars 134, 136 or a rocker on the base 112 can be used to cause the link 261 to go taught when the housing 230 starts to move out of its upright position.

Referring back to Fig. 17, it is appreciated that even when the cog 260 is engaged in the catch 264 and the cable 261 is slack, the lever 288 may be manually moved to disengage the drive mechanism such that the device 200 may be used as an active exerciser. Manual application of force to the lever 288 overcomes the frictional engagement of the beveled end 266 of the cog 262 in the catch, and the second spring 268 holds the lever 288 in the disengaged position (Fig. 18).

Referring to Fig. 19, a second mechanism for automatically disengaging the drive train from the pedals is shown. A preferably L-shaped lever bar 360 having first and second arms 362, 364 is rotatably coupled to the lever 388. The cable 361 is coupled to the first arm 362. When the cable 361 is pulled (i.e., when the housing 230 is folded), the lever bar 360 is rotated until the second arm 364 contacts the wall 184. Further rotational movement of the lever bar 360 causes the lever 388 to

move to the right, thereby moving the cam 382 relative to the cam slot 390, and thereby disengaging the motor drive from the pedals.

Turning now to Figs. 20 through 22, a fourth embodiment of a foot mobility device 400 is shown. In Fig. 20 the device is shown in a collapsed or folded configuration, with the pedals 418, 420 substantially flushly seated on a base 412 (Fig. 21), and a motor housing 430 also in a flush folded position. By pressing a latch release 450, the housing 430 is released from an engagement further discussed below, and the device may be moved into the open configuration of Fig. 21. Fig. 22 shows the maximum travel or rise of a pedal 420 relative to the base 412. The pedals rotate about axes through their heel portion 419, 421.

Referring to Figs. 22 and 23, a compartment 452 is provided on the base 412 under the right pedal 420 to house the electronics which control the hereinafter described motor assembly 454 (Figs. 25 and 26), and a battery compartment 456 is provided under the left pedal 418. Fig. 23 also better illustrates the above mentioned latch release 450 and spring-biased latches 458 which are adapted to hold and then release catches 460 on the end of the motor housing 430. Referring to Fig. 24, the pedals 418, 420 each also include a catch 462 which is caught under the motor housing 430 when the motor housing is in the closed position to hold the pedals in a closed position.

Referring back to Fig. 23, the housing is coupled to the base with a four-bar linkage 464. When in the fully upright position of Fig. 23, the housing 430 rests on the base 412.

Referring again to Fig. 24, the pedals 418, 420 have a rear depressed area 470, 472 which functions as a heel rest. In addition, the pedal is wider at the heel end. The user's feet can be placed laterally on the heel ends to position the feet in a relatively parallel orientation, or the feet can be placed medially on the heel ends to splay the feet. The foot position can be selected according to user comfort.

Referring to Figs. 24 and 25, the pedals 418, 420 are preferably coupled to the motor assembly 454 with ropes 474, 476. The motor assembly 454 includes a gear train 480 coupled to a preferably vibrationally-isolated motor 482. The gear train 480 includes a main pulley gear 484 and left and right idler pulleys 486, 488. One rope 474 extends from the left pedal 418 clockwise about the left idler pulley 486 and then clockwise about the main pulley gear 484 to which it is then attached. The other rope 476 extends from the right pedal 420 counterclockwise about a right idler pulley 488 and then counterclockwise about the main pulley gear 484 to which it is also then attached. Reciprocal rotation of the main pulley gear 484 by the gear train 480 causes the

pedals 418, 420 to move in an up and down motion about axes through the heel portions 419, 421 of the pedals.

Referring to Fig. 26 and 27, a switch 490 is coupled to a linkage 492 which is coupled to an idler gear 494. The idler gear 494 is coupled to the motor 482 and can be brought into and out of engagement with a portion of the gear train mechanically coupled to the main pulley gear 484. The linkage 492 is subject to the force of a spring 496 (Fig. 26) which stably holds the idler gear 494 in its current position until sufficient manual force is provided to the switch 490 to move the linkage 492 and thereby alter the position of the idler gear 494. The switch 490 also operates to provide and remove power from the batteries (in the battery compartment 456) to the motor 482; i.e., to power 'ON' and 'OFF' the device.

In Fig. 27, the switch 490 and linkage 492 are positioned to provide the device in the 'OFF' mode and to locate the idler gear 494 out of engagement with a gear 498 directly engaging the main pulley gear 484. In this configuration, the device may be used in an active mode; i.e., with the user providing the power to rotate the pedals. In Fig. 28, the switch 490 and linkage 492 are positioned to provide the device in the 'ON' mode, and locate the idler gear 494 in engagement with gear 498; i.e., such that the motor assembly moves the pedals in a reciprocating motion. In

addition, a clutch 500 is provided to prevent damaging force from being applied to a portion of the gear train and the motor, e.g., if a user were to apply foot pressure counter to the movement of the pedals by the motor assembly 454.

Turning to Fig. 29, a small L-shaped lever 502 is provided adjacent one of the supports 504 of the four bar linkage 464. If the device 400 is folded while the motor is engaged, upon folding, the L-shaped lever 502 contacts a rocker 506 which operates to move the switch 490 to an OFF position, thereby disengaging the pedals from the motor.

Referring to Fig. 30, a passenger compartment 510 of a vehicle, e.g., a car, a truck, a plane, or a train, is shown. A foot mobility device 400 according to the invention is coupled to or integrated into the floor 512 of the compartment 510. As the embodiments of the devices can each be folded to assume a relatively low profile, when not in use the devices do not substantially encroach upon the leg room in the compartment.

From the above, it is appreciated that several embodiments of the device can be used in either a passive (powered) mode or in an active (non-powered) mode. In the active mode the user simply pushes one foot down causing the device to raise the other foot, and thereby exercise the lower extremities.

In the above described foot mobility devices, the pedals operate to reciprocably move the feet about either the heel or ankle, but do not cause the exaggerated leg movement which results from rocking the feet, moving the feet about the ball of the foot, or pedaling the feet in a bicycle pedal motion. As such, the foot mobility device is particularly suitable for use in areas which provide little leg room and/or where it is desired to maintain the knees relatively still during use of the foot mobility device.

There have been described and illustrated herein embodiments of a powered foot mobility device. While particular embodiments of the invention have been described, it is not intended that the invention be limited thereto, as it is intended that the invention be as broad in scope as the art will allow and that the specification be read likewise. Thus, while particular gear assemblies have been disclosed, it will be appreciated that other gear assemblies using fewer or more gears, and/or different types of gears can be used as well. In addition, while preferred housing designs have been illustrated, it will be understood that other housing designs can be used. Also, while the device is preferably battery powered, for portability, it is recognized that the device may be powered by an AC power source instead of a DC battery source, or by an AC power source which either bypasses the battery power source or can be used to recharge a rechargeable battery source. Furthermore, while in the second embodiment a

rope or other resilient element is used to move the pedals, it will be appreciated that other systems may be used to support and move the pedals. For example, gear-rotatable supports may be provided under the pedals. Also, while exemplar mechanisms for automatically disengaging the drive train for the pedals are described, it will be appreciated that other suitable mechanisms can be used. It will therefore be appreciated by those skilled in the art that yet other modifications could be made to the provided invention without deviating from its spirit and scope.